

ASSOCIATION OF INDIAN UNIVERSITIES
LIPPA DV

UNIVERSITY - INDUSTRY INTERACTION

Exploring Areas and Forms of Collaboration

(An AIU Study)



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FOREWORD

The primary function of the institutions of higher education is teaching and (in the case of universities) research. These functions are fundamental and ought not to be compromised, though they may be supplemented in a variety of ways. One area in which the universities can make significant contribution is the technological innovation which has come to play a strategic role in expediting the process of industrial development; which in its turn, leads to structural changes in the society and economy. Such changes necessitate transformation of the basis of productive activities by introducing new technology. The universities cannot, however, decide the nature and type of technology that would be most suited to the requirements of industry which, for its survival, faces the competitive world of business and commerce. In this context, the strength and extent of university-industry relations in undertaking collaborative activities are of immense value not merely in terms of mutual benefits from each others' services but also the overall productivity gains to the national economy. The successful partnership between university and industry, however, depends on academic excellence maintained by the higher education institutions and the clear articulation of needs of industry. The twin aspects of academic excellence and the formulation of an articulate industrial demand for technical know-how have always in themselves been the major

concern. The involvement of university scientists, at an early stage in the identification of problems of mutual concerns, may prove useful. There is therefore a strong case for exploring the areas and forms of Collaboration between university and industry. Such efforts are expected to alleviate the pressure of competition for the of industry, reduce the financial stringency on the side of the universities, and on the whole minimise the pressure from fundamental scientific and technological requirements of progress in many areas of research and development.

I am glad that Shri M M Ansari, Joint Director (Research) and Dr T.C. Sharma , Research Associate have made an endeavour to underscore the benefits and have accordingly outlined areas and forms in which university and industry can Collaborate. Their attempt to survey the extent of such cooperation that exist in a select number of universities is particularly revealing. I am sure that the content, the analysis of information and the emerging issues therefrom would stimulate fruitful discussion on such an important policy matter as the ways and means of forging sound relations between university and industry. It may well be hoped that university Professors and industrial managers would immensely benefit from reading this monograph as it aims at optimising productivity gains to the society by sharing physical and financial resources through the promotion of informal and formal contacts among them.

I commend this study particularly to policy planners, teachers in the university system and the leaders of business and industry.

S K Agrawala

Secretary

P R E F A C E

The Economics of Education Division is an active unit of Association of Indian Universities, the major functions of which are to carry out research, undertake consultancy work and organise seminars/conferences, in the area of economics of education especially higher education. In addition to carrying out its own research studies on the subjects that are considered to be important from the national point of view in terms of policy formulation, the Division also undertakes research projects on subjects of public interest sponsored by the national institutions.

The present study is an outcome of an on-going major research project on 'University-Industry Interaction' which has been undertaken with the following as the main objectives:

- i) to discuss and analyse the imperative need for promoting long-term linkages between universities and industry;
- ii) to identify the areas and forms in which the mutual cooperation and collaboration exist;
- iii) to isolate the factors that help or hamper such collaborations; and

iv) to develop a sound perspective for promoting informal and formal relationships among both university professors and industrial managers as well as universities and industries.

In this preliminary Report an attempt has been made (i) to outline the different areas and forms in which university-industry linkages could be established; (ii) to present and discuss the survey result of existing collaborative efforts made by a select number of universities; and (iii) to discuss the problems and prospects of collaboration in different areas of mutual interests to universities and industries. It must be pointed out that much of the discussion is influenced and biased in favour of the university concern for promoting the relations between University and industry for two reasons: One, in our first phase of the study, of which the present volume is an outcome, we could gather information from universities alone, and the concerns of industries could not be explored due mainly to the paucity of time. In the second phase of the study not only the University sample size would be enlarged but industries as well would be covered for preparing a comprehensive Report. Second, we believe that the university organisations would considerably benefit from industry supported collaborative efforts particularly in terms of additional finances which is most needed by them for vitalizing their teaching and research programmes.

This would, in turn, not only improve their internal efficiency which relate to the least cost and effective teaching but would also improve their external efficiency which pertain to the quality and relevance of their educational programmes. We hope that in the second phase of the study, as referred to above, entire gamut of issues pertaining to university-industry interaction would be dealt with in a comprehensive manner. Our success would however depend inter alia on the amount of feed back that we expect to receive on the present volume from the enlightened readers. The suggestions received from the readers of this volume would be appreciated and duly acknowledged.

In carrying out this study while the first author was responsible for planning, execution and the overall supervision of the project, the second author conducted the survey, held discussions with the university staff in lines of the pre-prepared questionnaire and prepared the preliminary draft. For the interpretation of results and conclusions drawn and for any errors and omissions that remain we above are responsible and not the organisation to which we are affiliated.

Without the cooperation of University Professors, Registrars and Finance Officers, who enthusiastically responded to our queries relating to university-industry relations, we would not have successfully completed our field survey which forms the main basis of discussions in this

Report. We are most grateful to all of them for their valuable responses.

We must confess that this study would not have been in the present form, had we not have the benefits of guidance and support from Professor S.K. Agrawala. He has also agreed to write foreword to this Report, for which we are most grateful to him. We are also thankful to Shri S.K. Barua and Mrs Z.S. Shafi for reviewing an earlier draft of the Report.

We are also grateful to Dr. V. Natarajan for sparing computer time and his valuable cooperation in making us available the services of Shri K.K. Giri who took the painstaking job of word-processing of the entire manuscript.

M M Ansari
T C Sharma

September 28, 1990

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Education-Productivity: The Nexus

Higher Education institutions contribute in a variety of ways to national progress especially through the development of human resources which constitute the ultimate basis for raising productivity and generating wealth of nations. The development of human resources is indeed both a means as well as an end in itself; and, therefore, almost entire exercises pertaining to socio-economic policy formulation, and planning and implementation strategies thereof, focus essentially on attaining the goal of human resource development. In economic sense, capital and natural resources are passive factors of production, whereas human resources are the active agents who accumulate capital, exploit natural resources, build social, economic and political organisations as the human beings alone have the ability to search knowledge, analyse information, innovate technologies and utilize the same in their day to day routine activities. Obviously, if a country is unable to develop the skills and knowledge of its people and to utilize them effectively in various socio-economic activities, it would be unable to develop anything else. In brief, it is the development of human resources of a nation, not its capital nor its material resources, that ultimately determine the character and pace of economic and social

development which, in effect, influence the well being of people.

It is against this backdrop that the National Policy on Education-1986 has observed that 'higher education provides people with an opportunity to reflect on the critical social, economic, cultural, moral and spiritual issues facing humanity. It contributes to national development through dissemination of specialised knowledge and skills. It is, therefore, a crucial factor for survival'. It follows that it is indeed difficult to conceive of a plan for building up a sustainable and prosperous society without the development of human resources which is dependent on the health and vitality of higher education and the national economy. Thus, higher education including research and economy are inextricably linked with each other. For instance, while the economy provides necessary resources for promoting the system of higher education, the latter prepares, in turn, a cadre of manpower with varying degrees of specialisation and levels of skills for increasing productivity of various factors of production, which consequently enhance income and improve the quality of life of people. Moreover, the programmes of higher education, pertaining especially to the theoretical and applied fields of studies, provide desirable perspectives and necessary framework for formulation of appropriate policies with a view to ensuring long-term sustainable development. The planners and policy makers have to be therefore genuinely concerned about the strength and vitality of the system of

higher education to make its maximum contribution to the fulfilment of changing and growing social needs of the society. Such a concern is justified even more strongly in developing countries like India which suffer not only from deficiency in physical and financial capital but also the abundance of labour force having much less than desired level of education and training as may be necessary to achieve the minimum rate of economic growth for sustainable development. In order for creating such conditions as would be conducive for ensuring better standard of living, the promotion of human resources by way of strengthening education system, in which the programmes at tertiary level are to determine the quality of service and guidance which, in effect, have significant bearing on productivity, is sine qua non for accelerating the pace of national development.

The experience of most of the developed countries reveal that they have thrived owing largely to the increase in threshold of education, training and skills formation. As the economies of both developed and developing countries become more knowledge and technology intensive, human resources would continue to become more central to economic progress. Almost in every country, though in varying degrees, the search for knowledge and new technology has become the major concern of national economies from a more strategic point of view since productivity is increasingly determined by the knowledge and skills workers put into their tasks. Human knowledge is the moving factor behind productivity

change and when the requisite knowledge is missing, output suffers; however much finance and hardware are supplied.

There seems to be two fundamental implications and policy issues emerging from such situations as above. Firstly, the minimum competence threshold for being able to function in the economy is moving upward. That is to say, it is becoming more and more difficult for the individual to perform in the emerging economy if s/he does not have the necessary skills. This is one of the key factors behind recent and renewed interest in education and training everywhere. The second implication is that there is a great risk that the new economic situation, if the system of education, training and skills formation are not improved, will create a dividing line between those who can and those who cannot perform because of their level of skills. The demands of new technology upon system of human resource development have, therefore, to be seen in the perspective of a more knowledge intensive economy. Hence, when new technologies lead to an increase in skills requirements, both within the work place and within the economy as a whole, systems of education and training must increase the quality and relevance of their outputs, which would, in effect, bring about overall improvements in productivity and production.

Since the inception of planning era, the foregoing considerations have led to a commendable progress in respects of expansion and diversification of higher education system

which has emerged out to be the third largest in the world. The factors like the growth of population, widening base of elementary and secondary education, equalization of educational opportunities and the growing realization among Indian people about the socio-economic value of education, have spurred the demand for higher education. By the end of the century, it is likely that the total enrolment at tertiary level would continue to rise at around 10 percent per annum and reach to about 6 million as against 4 million in 1988-89. However, even at this high rate of growth of enrolment, the share of students who benefit from higher educational facilities would remain merely about 6 to 7 percent of the total age-specific population. If this ratio is taken as a major indicator of human capital formation, it would mean that the quality of inputs into all the industrial and other productive enterprises would continue to be invariably low as compared to the standards of the economies with which India would have to compete. As a result of this, the quality and quantity of outputs would remain below the expected level which, in effect, would impede India's development efforts to occupy a place of prime importance in the comity of nations. Obviously, then the system of higher education ought to be examined very closely so as to ensure effectiveness in its multifaceted role that it plays. As against this backdrop of linkages between education and productivity, the university-industry interface is proposed to be examined in the following chapters.

Chapter 2

University-Industry Interaction

The Concern for Collaborations

2.1 The Background

Ever since the inception of planning era in 1951, rapid industrialization has been considered to be the key factor for improving the well-being of the people and accordingly steps have been taken from time to time to create the conditions for ensuring expansion and diversification of the industries at various scales of operations. Development of industries and their sustained growth require the inputs of technical and scientific knowledge so as to raise efficiency and reduce costs of production, to ensure better utilization of resources, to create know-how for appropriate technologies, and to adapt the imported technology to the local conditions. While the educational institutions have made commendable success in this regard, their contributions are much less than desired. Needless to say, the task of creating a proper technological and scientific base for rapid industrial and economic development principally lies with the university-level institutions. This is partly because these institutions are by and large still clinging to the traditional notion that the fundamental values to which universities owe their allegiance are for creation and

dissemination of knowledge which may not be directly related to the societal needs. Besides, the lack of adequate encouragement for promoting research in universities and continued dependence or preference for imported know-how on the part of the policy-makers, have also contributed to the growing isolation of universities from the mainstream of national economic life and industrial activities. The major role of the Indian university-level institutions has however been to supply the scientific and technical manpower primarily for operation and maintenance of the existing industries. Here too, due primarily to the lack of proper manpower planning in general, and the lack of coordination between universities and industries in particular, a high degree of mis-match is observable between the demand for and supply of highly skilled and trained man power. This has created a huge army of university degree holders who, on the one hand, are not required by the industrial sector, and on the other, the industrial sector is facing the shortage of highly skilled manpower in some key areas which have significant bearing on productivity.

In view of such a scenario of university-industry interactions in India, there are some specificities which are needed to be looked into at this stage. Firstly, there is a lack of mutual understanding, rather lack of mutual appreciation, between the academicians and industrialists/managers of the complementary nature of their individual fields of activities, which if properly harnessed could

herald a new era in India's processes of industrial development. The academicians have a tendency to think that the industrialists/managers hardly do anything more than the routine maintenance of imported machinery and the industrialists/managers in turn think that the academic staff do little more than chalk-talk that too from books of foreign authors or outdated reading materials.

Secondly, much of the researches conducted at the institutions where adequate infrastructure facility have been created, are in such areas of knowledge which are not relevant for the promotion of industries.

Thirdly, in spite of all the attractive facilities like money, machinery, material and preference offered for the unemployed graduates by the government and various other agencies to make them successful entrepreneurs, they are not as yet confident enough to take up challenges and rise to the occasion. The reason behind it is the lack of industrial knowledge and the requisite competence. In most cases they do not know the requirements of the society and the economy to select the product for commercial manufacturing. They are not sufficiently acquainted with the industrial set up required for establishment of any enterprise and the strategies to run it. They are moreover not fully conversant with the practical approach to co-ordinate the inter related aspects such as financing, marketing and sales promotion etc. While it is true that it is not possible to provide complete background

necessary for the students to become entrepreneurs in the curriculum, it should, however, provide sufficient guidelines and prepare them to be able to undertake an industrial venture.

Fourthly, the creation of national research agencies like the Council for Scientific and Industrial Research (CSIR), the Indian Space Research Organisation (ISRO), the Department of Atomic Energy (DAE), the Defence Research & Development Organisation (DRDO) etc. outside the university system have adversely affected the teaching and research activities of universities. Due to better emoluments and job opportunities, researchers are attracted towards the laboratories under these research agencies and, as a result, the universities are depleted of their good research workers and find it difficult to recruit new ones.

Finally, the funds available to universities being meagre, they find difficult to equip the laboratories properly with instruments and mechaneries required for advanced research work in industrial fields.

The results of all these have been obvious. Except for a few university-level institutions like the Indian Institutes of Technology (IIT), the Indian Institute of Science, etc, the majority of university-level institutions in India have turned out to be the producers of a vast army of degree- holders with knowledge having little relevance to

the world of work. Moreover, a number of publications of the faculty members are of either dubious quality or of no much use for the industrial sector. Under such circumstances, the university-level institutions have been put on the defensive even in fulfilling their traditional objectives of creation and dissemination of knowledge for its own sake, not to talk about gearing themselves up for meeting the emerging needs of the society in general, and those of the economy in particular.

2.2 The need for University-Industry Interaction

During the last few years, there has however, been an increasing awareness that the university-level institutions with their highly talented staff should play a major role in national development. This awareness has led to some steps being taken in some of the institutions to build closer contacts with industry. By developing such contacts the universities are expected to get cooperation from industrial executives to make teaching and formulation of their research projects more relevant to national needs, while the industrial executives are expected to receive advice and guidance from academics to solve their problems in improving productivity and raising the volume of production. In visualizing university-industry co-operative efforts, both the educators and industry-leaders therefore must foresee some areas of mutual advantages or benefits as under:

The benefits of university-industry interactions should accrue to students, faculty members, university-level institutions, industries and the public.

Students should benefit from the relationship with industry by being exposed to practical problems through contacts with industrial-scientists, by improving their prospects for employment through internship and summer employment as well as special recruitment programmes that are established through such relations. A large number of pre-doctoral graduate students and post-doctoral research associates receive their initiation to research, sharpen their research skills by working on sponsored research projects. Contact with industry through sponsorship of research or fellowship, or through work-study programmes brings financial support for the needy students, and in addition, an opportunity for the research apprentices to obtain valuable experience. There is the opportunity to learn the industrial perspective, to better understand those factors that motivate industrial research and to better appreciate the criteria by which research is judged to be successful.

Faculty members may individually benefit by industrial contacts that lead to consulting opportunities with accompanying additional income. Consulting also provides the faculty members with increased awareness of the state-of-the-art as practiced in industry, and provides material that can enrich class-room teaching as well. Consulting activities

provide an insight into the new areas of research and broaden the outlook for conducting research in applied fields. Industrial sponsorship of research programmes provides additional resources for university development. In some cases, industry is prepared to support research which falls outside the purview of the major sources of research-support for a given discipline.

The most obvious benefit to universities from closer relations with industry is the acquisition of new resources, in the forms of gifts, grants, research contracts and other forms of support for students, faculty and staff. Closer ties with industry also promise to facilitate technology transfer, so that a university might hope to benefit more from its patent and licensing operations. These ties with industry may offer an opportunity for university to convey its aims and programmes better to corporate leaders who may help them in better appreciating the potentials of universities for innovative training and research. Worthwhile results can be obtained in some cases when facilities including technical manpower that are available in the respective institutions are mutually shared for working on developmental problems. Many industrial research projects undertaken in university laboratories cannot be brought to function unless investigations at the final stage are carried out at plants.

Industry has depended upon universities as the source of trained manpower at both the degree and advanced degree levels. The coupling of graduate education with research in universities constitutes an apprenticeship system that enables research scientists and engineers to function in a highly competitive industrial environment with a minimum of on-the-job orientation. At the same time, industry looks to university research as source of new ideas and developing technology. The existence of established fundamental research programmes in universities provides industry with access to experts in certain fields, without the need for extensive in-house investment in those areas of basic research. The establishment of strong ties with universities is especially important for the newer knowledge intensive industries that are expected to account for most of the growth in industrial production during the next few decades. Such industries characteristically invest heavily in R&D expenditures, and are critically dependent on the continuing flow of new personnel, for staff expansion and to replace engineers and scientists whose technical background become outdated.

Industry benefits from the research results and from access to the ideas and results of active university research laboratories. They can also benefit from reduced time in transferring the results of research for commercialization. They also benefit from the enhanced training opportunities offered to their present and future employees.

The community or public derive benefits through the provisions for: (a) better all-round education programmes which help in raising the standard of living , (b) facilitating entry of new industries into the locality where technical education can help provide training and employment opportunities, and (c) demonstration to the members of the community that education is a continuous process and therefore adults should go to university for improving their abilities to handle their jobs, or to move on to the better positions and thus utilize their fullest potential. The various forms of industry-institution collaborations, which ensure the accrual of benefits discussed above are described in the following section.

Chapter 3

Some forms of University-Industry Collaboration

In this Chapter an attempt is made to identify the areas in which industry and institution could possibly collaborate for mutual benefits. The various forms of collaboration may be broadly classified as follows (i) student-centred activities; (ii) teacher-centred activities; (iii) provision of resources; and (iv) other collaborative activities. These are discussed below in seriatim.

3.1 Student-Centred Activities:

Student-centred activities usually consist of industry's participation in the teaching Process, arranging in-plant training, field visits for students, development of curricula, placement of students etc. The major objective of such activities is to make the students conversant with the various technical problems faced by the industry as well as the recent advances accomplished in different areas of industrial undertakings.

3.1.1 Industry's Participation in the Teaching Process:

Industries often offer the services of some of its senior persons either on a full-time basis for a period of one or two years or on a part-time basis, so as to ensure

that a certain percentage of the teaching staff represent the practical world of industry. Such an arrangement is made since the very initial stage of commencing a particular course of study, namely, the determination of the objectives of the different programmes or courses of study, and the preparation of the curricula and course materials. Such an arrangement is mutually beneficial as the persons so deputed bring back with them new knowledge and fresh outlook to the industry after the end of such contracts.

The industries should therefore encourage and spare some of their interested staff members to participate in regular teaching programme particularly in practical and lab based courses. This may necessitate the practicing scientists and engineers to stay for a longer period in the campuses and let the educational institutes have the benefits of such feed back for raising the relevance of educational programmes. This would supplement the academic programmes and provide the necessary practical bias. Moreover the industrial executives particularly of research departments should also be invited as external examiners for undergraduate as well as post graduate examinations so as to enable the industry to be acquainted with the research and training programme of the institute.

To facilitate such arrangements, many of the rules which regulate the appointment of teachers at present in most of the educational institutions would have to be

substantially modified. Educational institution should also invite leading industrial managers and technical experts to give lectures on specific topics and subjects. Even a most busy executive would be tempted to undertake such an assignment as a challenge to his own abilities and experience.

3.1.2 Development of Curricula

The curriculum for a Master's degree or Bachelor's degree programme in any discipline should be prepared and finalised according to the needs of private and public sector industries. In this regard, institutions should invite specialists from industries and research institutions so as to ensure that the academic programmes are duly oriented to meet the requirements of industry. As the educational institutions are autonomous, they can prepare curricula according to the needs of the organisations which use their outputs i.e. students. For this purpose, the Board of Study must include the qualified and experienced personnel from the industry as members for preparing and modifying the syllabus to make it more industry oriented. In a number of educational institutions, this practice is very common though it is not effective to the desirable extent except in IITs and some other professional organisations which have been established to meet the requirements of industrial organisations.

3.1.3 Practice School:

Some of the B. Tech. & M.Tech., theses may be planned in consultation with the practising engineers of the industry such that the students might have to spend some time, say 3 to 6 months, in the industry. The study report may focus on some aspects of plant operation or on experimental work conducted in the laboratory of the factory. The students may be given free boarding and lodging at factory premises during the study period.

3.1.4 Providing Facilities for Training:

Any amount of theoretical knowledge without practical experience will not make a student of technology capable of taking up his profession with confidence. Theory must be tested against existing practices in order to make the theoretical knowledge purposeful and useful. Properly planned and effectively executed field work for reasonably long periods alone can ensure rich dividends from a technical education.

What goes on today in the name of practical training with industry wherever it exists, is indeed a mockery of the very idea of training. The students spend a few days holidaying through the corridors of the offices and the premises of the factories. Often, instead of getting any insight into the practical problems of their chosen fields,

they come out with all sorts of funny ideas and misconceptions about the industry and its working. For this sad state of affair, the educational institutions or the students are not alone to be blamed. The industries should adopt adequate measures and provide financial incentives for motivating students to make the best use of their training period so as to make them an active agent of industrial revolution. A small amount of finance earmarked for such a purpose by the industry would go a long way to get the best out of the project. All this needs a willingness to take some initiative by the industry and extend its wholehearted cooperation to the cause of effective technological education. It is important to emphasise that industrial training could be made more meaningful and productive, particularly at the post graduate level if it is programmed in consultation with teachers of the institutes keeping inview the research and consultancy requirements of the industries.

3.1.5 Arranging Inplant Training for Students:

The advances in technical education demand a purposeful system of practical training in the educational institutions and industries. Since a comprehensive practical training cannot be provided in the educational institution for different reasons, it is necessary to establish a liaison between industries and educational institutions so that the students will have opportunities to visit industries more

often and spend a part of their time in the factory premises especially during vacation. Students who study their courses at the institutes will have the desirable exposure to the world of work, which, in effect, will make their education and training more effective and productive.

3.2 Teacher-Centred Activities

Teacher centred activities are generally confined to training and recruitment of teachers, membership of teachers in governing bodies of industries etc. This type of activity has the three dimensional approach whereby students, industrial personnel and teachers are benefitted.

3.2.1 Training for Teachers

While training for students is considered important and quite a number of schemes are existing for this purpose, it is essential to train the teachers as well particularly on the practical side of their subjects of specialisation. Not many such schemes are presently available. A teacher, working even for a short period in his own field of specialisation in an industry, would find it as a very rewarding experience. An opportunity to work and study in an industry would help a teacher to broaden his outlook and provide him an opportunity to grasp the practical aspects of various problems. The proverb that "what you read you forget, what you see you remember and what you do you understand' is true equally to students and teachers. Such experience would surely help him

in his own sphere of research and development and more importantly help him in understanding practical aspects and requirements and would develop him to train the students better at the levels of both under graduate and post graduate. The staff of industries would simultaneously benefit from such periodical visits to an industry by an 'academic person' who would provide an opportunity to the persons concerned in the industry to discuss some theoretical problems in detail.

In view of the foregoing, the problem of preparing the teachers to equip himself adequately to meet the challenge of his profession, can be tackled by industry alone. Industry must provide opportunities and the necessary facilities for teachers. One way of doing this is to welcome those who are engaged in research to collect relevant materials and data and assist them in every possible manner to conduct their investigations satisfactorily. Many industries are reluctant to extend these facilities. In fact, most of them look upon such research workers as a nuisance if not interlopers or undesirables to be let in. This attitude has to be changed. It should be remembered that every successful research scholar is a potentially competent teacher, who will handle his classes with intimate knowledge of the practical problems of industry if he has had opportunity to study at close range.

Another possible way is to give interested teachers full time assignments in industry for varying periods of one to three years. Wherever possible, this should be done on an exchange basis between the industry and the educational institution although this is a formidable problem under our present system of rigid organisational constraints. If this is not practicable, industry should at least show its willingness to accept a teacher for a specified period as and when an educational institution requests for such an assignment with a view to developing the professional competence of the teacher. On its part, the educational institution should make such an arrangement a regular and continuous feature in the process of building up a competent faculty.

The next possible way is to encourage teachers and technical men from industry to work in collaboration on problems of common interest. Specific problems can be assigned for such collaborative ventures which are bound to prove stimulating for both parties and mutually rewarding for the institutions. This is perhaps the most effective way in which theory and practice can supplement and compliment each other and the frontiers of technological knowledge can expand and intensify for the betterment of the society and the economy. Such collaborative ventures are of immense success among the technologically advanced countries.

3.2.2 Full time Industrial Experience for Engineering Teachers and Researchers:

Educational and research institutes should permit and encourage their staff members to spend some period every year in the industry as full time employee ranging from a month in the summer to a year on leave from the institute without causing any loss to the facilities like continuity, usual annual increment, and residence in the home campus as well as in the factory campus.

The industry should pay some maintenance allowance if not salary to the teacher or researcher working in the factory. In addition, the teacher (or the researcher) should be paid for his occasional travel to keep up his research programmes at home campus. Because of the want of experience, teachers or researchers become disqualified for an appointment in industry which causes frustration among engineers in teaching and research profession. The industrial experience, thus earned, should be considered as an added qualification for promotion and other professional benefits. Such an approach would bring about considerable improvements in industrial productivity by way of stimulating the process of learning and skill formation.

3.2.3 Membership of Governing Body

Eminent educationists/academicians should be nominated on the Board of Directors of industries and the leaders in industry on the Boards and Advisory Bodies of educational

institutions. This method of sharing expertise in techniques of management of institutions and industries, which is already in practice to a limited extent, would go a long way in promoting their partnership for accelerating the pace of development.

3.3 Provision of Resources:

The industries can make substantial contributions for promoting excellence in teaching and research by way of providing the needed resources especially in the forms of donation of laboratory equipment, research fellowships and endowed chairs.

3.3.1 Industry Contribution for Research Facilities

The industrial enterprises can provide substantial foundation funds to build research facilities. The linkage and cooperation between local companies and a university's administrator could facilitate the creation of infrastructural facilities with the university for the benefits of its own teaching and research assignments as well as the company's research needs.

3.3.2 Donation of Laboratory Equipment:

The Companies and the manufacturing houses some time donate equipment to local universities to upgrade research and training facilities in an area of their interests. Such assistance help built up the university's technical

capabilities and are useful for both teaching and research purposes. It is seen as a way to foster good communication between university and industry.

3.3.3 Industry Funded Research Fellowship

The research fellowship support is an integral part of a more extensive cooperative university-industry programme. It is also a mechanism used by companies when they have limited funds to spend on university research especially in the areas which support the companies programmes. It is a way of getting a higher value for their limited research fund. It also provide an incentive to the receipient of the fellowship, who after the completion of the study get absorbed by the companies.

3.3.4 Industry Endowed Chair

The chairs can be enestablished in academic institutions by industrial organisations to carry out high quality research in the specialised areas. A number of industrial organisation like BHEL have already established chairs with the educational institutions. Most of the universities seek to increase the number of industrial endowed chairs within their science and engineering departments, because this is a mechanism, whereby the institutional programmes are funded.

3.4 Other Collaborative Activities

Under this category, the other possible forms of university-industry collaboration may be included especially those having joint research endeavours, cooperative participation of university and industry scientists in contract research. In such cases the two parties jointly plan their research programmes.

3.4.1 Conduct of Research Relevant to Industry

The practice of industry entrusting educational institutions with research assignments is very limited to the institutions of national importance like IITs. On the one hand, industry has no confidence in the ability of the educational institutions to deliver the goods, the latter, on the other hand, are yet to demonstrate their interest and competence to deal with the practical problems which confront the industry. Our governments, both at the Centre and the states, are equally responsible for creating such a situations as no worthwhile effort has been made to promote their interactions. They are yet to make a worthwhile beginning in this direction, while the advanced countries spend several millions of dollars annually to finance research projects entrusted to universities and other higher educational institutions and the finances are made available through the industries.

Undertaking research on the problems of industry by educational institutions means the handling of such problems in the class rooms and the laboratories of these institutions. That is one of the surest and most effective way of building up a faculty deeply involved in practical problems and preparing a student body ready to deal with such problems as and when they come out and take up positions of responsibilities in industry. It helps, moreover, in abridging the gulf that separates the academic and the industrial worlds.

It would therefore be desirable that all the large scale industries should establish their own research and development wings which should work in close liaison with educational institutions. A broad division of work can also be made such that theoretical researches could be undertaken in educational institutions and the applied researches could be carried out in industrial establishments. It is possible for technological institutions and research organisations to inform industries about their facilities for research and development as also the progress of the various projects undertaken periodically. This would facilitate the industries taking advantage of expertise available with these institutions.

Another area in which industry can render assistance to technological institutions is the area of scholarship and fellowship or some other financial assistance for attracting talented graduates and also for setting up pilot plants,

experimental workshop, production centre etc. There is also considerable scope for undertaking joint investigation and research activity relating to projects, processing of material etc., including faithful copying of foreign products and machinery. Moreover, joint studies can be undertaken on such important problems as air pollution, water pollution, transportation, location of industries etc, which are of great regional and even national significance.

In this context, the formation of Research Councils to improve the interaction between the two sectors is highly desirable. These research councils will consist of specialist members from faculty, research institutes and R & D wing of industry. The specific problem of industries could be referred to the council which will plan for the development in a way that the work can be started simultaneously at different laboratories of the educational institutions as well as that of R&D wings of the industries. Meeting of the Council should be held frequently so that the plan of the work can be assessed from time to time. The research expenses may be borne in part by the participating organisations depending on the nature of the problem and mutual arrangement in such ventures.

3.4.2. Government Funded University/Industry Cooperative Research

Some times universities and industries come together to

conduct research as part of a national effort in a particular area especially through the governmental efforts. Cooperative industry/university research proposals are prepared jointly by academic and industrial researchers and submitted jointly to the concerned institutions. Such an approach encourages joint efforts to solve the national problems. The success of such mutual endeavours is dependent on (i) strong and active research collaboration between university and industry researchers in the performance of the proposed project so as to ensure industrial relevance of the research (ii) significant costs sharing by the industries and (iii) high quality of proposed research.

In addition to joint research projects, the government's research sponsoring agencies also provide fund for carrying out research projects in the areas of industrial relevance. In this regard, university professors submit their research proposals directly to the sponsoring agency for necessary funds. The academic staff of educational institutions are needed to be encouraged under such programme, as above, by way of providing the physical and financial resources for carrying out research activity of high standard.

3.4.3 Research Problems for Dissertation/Thesis

The topics chosen for dissertations and theses of the post graduate students should be in an applied and problem oriented areas of specialization. Wherever possible, before

the actual commencement of the thesis work, the candidate and his guide should explore the availability of the facilities for research and accordingly take a decision about the scope and objectives of the research thesis, the findings of which should be to the best advantage of the educational institutions on the one hand and industry research institute on the other.

3.4.4 Consultancy

Consultancy as a profession or occupation is still in its infancy in India. Although the big cities like Bombay, Calcutta and Delhi have a few well established industrial consultancy firms, their impact on industry as whole at present is negligible. But those who are aware of the role of consultants in advanced countries would not hesitate to acknowledge the very useful services they have been rendering to industrial vitality and technological innovation.

In India consultancy services are provided by a small educational institutions and that too, to a very limited extent. In view of economic and technological backwardness, the educational institutions can play a commendable role in the field of consultancy. This is because these institutes have the largest concentrations of the most qualified men in various areas of science and technology. If a problem which an industrial concern wants to investigate is entrusted to such an institute, it should be possible to deal with it satisfactorily by pooling the expertise available in the

institutions. As the institutes gain more experience in this type of work, it can create suitable institutional machinery to handle the consultancy work.

A beginning has to be made in this new area in a vigorous way. The initiative in this regard should come from the industry and the educational institutions must accept the challenge. The Chief administrators of university/institution should encourage their staff members to industrial consultancy by creating facilities for this. The industry in particular should frequently communicate their problems to the faculty which might give rise to new educational programme of national interest. A portion of the R & D fund of the industry should be diverted towards this direction. Consultancy work in due course will immensely improve the quality of both teaching and research which would, in effect, turn out to be an advantage to the industry.

3.4.5 Information centre

The importance of communication-cum-information centre cannot be underrated. For promoting industry-institution interface, some mechanism should be evolved whereby the relevant information could be exchanged and shared especially with regard to the available facilities with the institutions/industries, the ongoing activities and the developmental aspects which are to be tackled. Hence, it is

desirable to have such central communication-cum-information cell.

3.4.6 Organising seminars

The conferences and seminars should be organised on subjects of mutual interest. This will go a long way in establishing a cordial relationship between educational institutions and industry. Needless to emphasise, the seminars and conferences provide a common platform for the industrialists and educationists for sharing views on the issues of common interest. For effective collaboration, it is necessary that this method should be adopted on regular basis in industry as well as in university so as to ensure closer ties between them.

3.4.7 Short term courses

One of the problems of industry is to keep their engineers away from obsolescence. In order to overcome this problem it is desirable to organise condensed refresher courses in the industry where specialists should be invited to offer such courses. The staff from industry can attend such courses so that they can keep abreast with the technical advances accomplished in their specialised fields. The curriculum should include sandwich courses and training programme as well. In brief, short-term courses should be pin-pointed and oriented to give a strong dose of knowledge

within a short time. These courses need not only be theoretical but also may have a certain amount of practical and laboratory orientation depending on the newer instrumentation and equipment.

Chapter 4

University-Industry Interaction: The Existing Scenario

This Chapter seeks to present an array of current university-industry interactions in Indian universities. The analysis of information pertain to the seven universities and university-level institutions in respects of the Faculties of Engineering and Technology, Natural Sciences, Commerce and Management and a few departments of Social Sciences. A distributional analysis of the number of departments of various institutions from which the relevant information have been gathered and analysed is presented in Table-1. The questions on which the responses were solicited from the academic community of the concerned departments are listed at Appendix 1. For analytical convenience, the different forms of interactions are divided into four major categories namely

1. General Research Support;
2. Cooperative Research;
3. Knowledge Transfer; and
4. Technology Transfer

Table-2 presents the variety of interactions which are observable in the campuses of the select universities.

Table 1**Distribution of Faculties/Departments - By Institution**

University/ Institution	Number of Departments				
	Social Sciences	Commerce & Management	Natural Science	Engg. & Tech.	Total
IIT Delhi	1	1	5	14	21
M S University	5	3	5	8	21
University of Delhi	5	2	10	10	27
Univ. of Rajasthan	4	3	8	-	15
Jamia Millia	4	1	5	3	13
Bhopal University	3	2	5	-	10
R S University	4	-	5	-	9
Total	26	12	43	35	116

Table - 2

Types of University-Industry Interactions within Four Major Categories

General Research Support	Cooperative Research Support	Knowledge Transfer	Technology Transfer
1. Monetary Gifts	Industry funded contact Research Specific to Research Programme of Project	Personnel exchange	Extension services
2. Equipment donation	Industry funded Research Fellowship	Mechanism for stimulate personal interactions - Advisory Board, Seminars Speakers programmes, Publication exchange	
3. Industrial Contributions	Govt. funded University/Industry Co-operative Research	Consultancy	
4. Industrial Indowed Chairs	Jointly owned or operated facilities and equipment	Adjunct professorship	
	Informal cooperative interaction-co-authoring papers, equipment sharing, information sharing.	Industry's participation in the teaching process	
	Preparation of curriculum	Seminars and short-term courses	
	Industry funded medals		

4.1 General Research Support

The general research support from industries to universities usually consists of gifts in the forms of money and equipment for strengthening of university research. Table-3 present the relevant data pertaining to financial support provided by industries under various collaborative programmes. The major objective of this type of collaboration is to provide support for maintaining excellence in university research rather than for strengthening university-industry research ties as is evident from the following discussions.

4.1.1 Monetary Gifts

Monetary gifts from industry are valued highly by university authorities/scientists because these provide additional financial resources for carrying out researches in areas of both academic and industrial interests. Sometimes monetary gifts are also made available for supporting general researches carried out by graduate students. During our field survey, several Professors mentioned that unconditional 'grants-in-aid' (i.e. gifts) to academic departments were significant in terms of their impacts upon graduate programmes of studies. There was, however, a general feeling among the university professors/scientists that unrestricted gifts or grants-in-aid did not necessarily promote healthy interactions between universities and industries. This was

Table - 3

Source of funds for Research & Development, 1986-87

(in Rs. lakhs)

University	Sources of funds				Total
	Govt.	Sponsoring* Agencies	University-	Industry	R & D Expenditure
1. IIT Delhi	186.7 (53.19)	99.5 (28.35)	-	64.8 (18.46)	351.00 (100.00)
2. Univ. of Delhi	8.3 (3.61)	221.9 (96.39)	-	-	230.2 (100.0)
3. M S University	35.7 (65.50)	16.3 (29.91)	0.9 (1.65)	1.6 (2.94)	54.50 (100.0)
4. R S University	2.9 (34.12)	4.4 (51.76)	01.2 (14.12)	-	8.50 (100.0)
5. Univ of Rajasthan	16.2 (32.14)	34.2 (67.86)	-	-	50.40 (100.0)
6. Bhopal University	0.3 (3.53)	8.2 (96.47)	-	-	8.50 (100.0)

Source: Universities Budget Estimates for the Year 1988-89.

Note: Figures in Parenthesis are the percentage to total R & D expenditure.

* These agencies include the Council for Scientific and Technology, Indian Council for Medical Research etc.

somewhat contrary to the general expectation that monetary gifts could strengthen university-industry interactions. Several university scientists maintained the view that voluntary financial gifts by industries to universities were rare and difficult to obtain.

4.1.2 Donation of Laboratory Equipment

Out of the seven campuses we surveyed, four universities received equipment as gifts from industry. Actually, companies donated equipments with sponsored research projects. The university scientists stated that industrial equipment gifts, except under special circumstances, were not yet extensive. However, a few cases were cited by the scientists when companies donated equipment with the sponsored research projects without the money for their maintenance. Some academic personnel also stated that while the companies were willing to sponsor research projects, the departments/universities did not have well-equipped laboratories for carrying out the relevant research. The academic staff were also of the opinion that company donated equipments were often not useful even for sponsored research projects.

Another mode of supplying equipment was found to be the so called 'loan agreement'. In this type of arrangement, a company provides equipment to a university on loan basis, but retains the title in order to depreciate the value of the equipment. At the termination of the agreement, of course,

the equipment reverts back to the university.

4.1.3 Industrial Contributions for Research Facilities

Industries occasionally give funds to universities to build research facilities or buildings. Sometimes, this is an out come of a university's general fund raising efforts.

Most of the academics/scientists, we interviewed, said that such funds were available on rare occasions. Most of the new laboratory buildings were built with governments/UGC funds. In the last few years, Govt./UGC for building research facilities have declined.

4.1.4 Industry Endowed Chairs

Industrial endowments for establishment of Chairs have been another source of support for univesity research in the Indian universities. The scientists who hold the industrially sponsored Chairs or Professorships were apt to be sensitive to the needs of the concerned companies. They arranged frequent meetings between company respresentatives and university personnel and encouraged discussions on problems of mutual interests.

All the universities covered by our survey were found to be actively engaged in seeking to establish industrially endowed Chairs within their science/engineering departments. However, IIT Delhi and M S University, Baroda were found to

be particularly successful in attracting this sort of industrial support. IIT Delhi was found to have two endowed Chairs and M S University of Baroda one endowed Chair in the department of management education.

4.2 Cooperative Research Support

Cooperative research interactions require some degree of cooperative technical planning, at least in the initial phases of negotiation. The major objective of such support is to strengthen company and university research ties. We present below those categories of research support and interactions that provide for an element of cooperative research interactions between universities and industries.

4.2.1 Industry Funded Research Project

On many occasions, person to person interactions turns out to be the most important form of university-industry cooperation. Out of the seven universities we surveyed, two i.e. IIT Delhi and M S University of Baroda, stated such types of collaborations. In 1988, there were thirty-five industry-sponsored research projects to different departments/ Centres in IIT Delhi, while in M S University, there were only five which were concentrated in the faculties of engineering and management.

An integral part of such research agreements was found to be the frequent contacts made among the scientists of universities and industries and provisions made for mutual

exchange of scientific personnel. The principal investigators of these programmes almost always were found to have separate consulting agreements with the sponsoring companies. In most of the cases we reviewed, the scientists usually had previous research interactions with representatives of the concerned industries. Two company representatives mentioned that they would not consider such arrangements unless they knew the university scientists extremely well. Another prerequisite for such arrangements were stated to be the desire of a company to extend its research capabilities into new fields with a view to developing new products.

Cooperative research agreements were considered by many scientists to be the most important contributing factor in the processes of industrial innovation as these programmes provided long range time-frames which were congenial for innovative research. Such programmes also required a consistent level of funding, calling for, at the same time, considerable commitment on the parts of the universities and industries. The long term partnership contracts between universities and industries therefore required that atleast, in certain fields, both the partners should be capable of displaying such commitments. Some senior university scientists mentioned that continuous and consistent levels of funding provided by industries occasionally enabled them to carry on multi-disciplinary research and also to hire technical personnel not directly related to their immediate research goals.

4.2.2 Industry Funded Research Fellowship Support

Industrial support to research in the form of fellowships could be an important method of strengthening cooperative research ties. The number and amount of such fellowships reported were, of course, very nominal. Out of the seven universities we surveyed, three universities had such type of collaboration i.e. IIT Delhi, -M S University of Baroda and University of Delhi. There were ten such fellowships provided by different industries in IIT Delhi, while in the M S University and University of Delhi there were four and two such fellowships respectively. The fellowships were generally provided to post-graduate and graduate students in engineering and management disciplines.

4.2.3 Government Funded University-Industry Cooperative Research

Funds for some of the cooperative university-industry research programmes are provided by many government agencies, including the Ministry of Defence and Commerce, CSIR, DST, Department of Energy and others.

In our survey all the universities, except Jamia Millia, reported that they had government sponsored research projects from such agencies like the CSIR, DST, ICMR etc. These projects were generally related to industrial problems. The funds, thus received, were however very limited.

4.2.4 Industry's Participation in Curriculum Designing

The curriculum for a Bachelor's and Master's degree programme in any discipline should be prepared and finalised only after extensive consultation with industries and related research institutions so as to ensure that the academic programmes could squarely meet the needs of the society in general and industry in particular.

In our survey, we found that in all the universities, except Bhopal and Rajasthan, faculty Chairpersons used to invite the industrial scientists for curriculum development. *This type of interaction was mostly found to have occurred in Science, Engineering, Commerce and Management disciplines.* Sometimes this type of interaction was also seen in the departments of psychology and social work. However, in IIT Delhi, this type of cooperation was a common feature across all the departments and centres.

4.2.5 Industry Funded Medals

While conducting our field survey and also reviewing of university publications like University Annual Reports, Budget Estimates etc., we found that all the universities except the universities of Bhopal and Ravishankar were receiving funds in varying quantities for awarding medals and prizes to brilliant students. Maximum number of such medals were awarded in IIT Delhi, where thirteen private industries

were awarding such medals; while in the University of Rajasthan, Baroda and Delhi seven, four and three private industries respectively were offering such medals.

4.3 Knowledge Transfer

Transfer of knowledge can be facilitated in a variety of ways. Knowledge transfer mechanisms mainly through personnel interactions are important in forging stronger research ties between universities and industries. They involve both formal and informal programmes that may or may not have scientific or technical knowledge transfer as their primary purpose. In our survey, four industries were asked as to which type of collaboration with university they would prefer. All the four were in favour of personnel interactions.

4.3.1 Personal Exchange

Personnal exchange between universities and industries is an important form of university-industry corporation. The practice of personnel exchange is implemented through both formal and informal programmes such as visiting professorships, assignments at universities in area of mutual interests, consultancy, seminars, participation in intensive workshop and lectures by industrial scientists etc.

A majority of academic staff contacted by us expressed the view that personnel exchange, when it occurred was a fruitful interaction. However, the formal university-industry exchange programmes at institutions like IIT Delhi and university like M S University, Baroda were institutionalised. In the remaining five universities, a limited number of staff participated in personnel exchange programmes.

Faculty members from IIT Delhi, indicated that a small number of scientists came from companies on a temporary basis to conduct research at the institute and all these were successful ventures. In these cases the companies sent their staff for conducting research and paid their salaries and the institutional fees etc.

In one programme, a faculty member of IIT Delhi worked at a local company, while two scientists from that company came to the institution to conduct research. This programme was a success. Those who came to the IIT from industry brought an industrial research approach which served to broaden the knowledge of faculty members and students. On the other hand, the professor who went to the company came back with a new outlook.

A large number of scientists from universities and industries interviewed stated that they would welcome improved formal programmes of personnel exchanges and would welcome

new initiatives in this area. Sabbatical programmes at industries are of increasing interest to both university and industry scientists. Sometimes personnel exchanges emanate from an opportunity to participate in consultation projects.

At the time of survey, we identified certain difficulties inherent in personnel exchange programmes. For instance, first the problem of disruption of family life. Second, if a company was having economic problems, it would fail to encourage this type of programme. Third, if the subject area was in the high technology field, or a fast moving field of science, it created problem for the university scientists to be out of contact with his department for long and it was also difficult for the industrial scientists to be out of contact with their industries for long. Therefore, if such programmes were institutionalized, a scientist might be assured of a position equivalent to or better than the job that he might have to leave. A few university scientists expressed concern that the faculty members, after working in industry, would be tempted to remain there due to offer of higher salary.

A majority of the staff were of the view that any workable and large formalized exchange programme would have to be flexible in terms of supportive time and resources. Most however felt that one to two months was a reasonable length for a good and fruitful interaction since one year would be too long for those concerned about career

development.

4.3.2 Mechanisms for stimulating Personal Interactions: Advisory Boards, Speakers Programmes, Exchange of Publication.

The practices of fostering personal interaction such as representation on advisory boards, participation in speakers programmes, exchange of publications and adjunct professorship, were pointed out by most of the respondents as activities which could lead to greater cooperation between universities and industries.

Many faculty members from IIT Delhi and from universities like M S University of Baroda, University of Delhi and Ravishankar University stated that they were affiliated to different industries as advisors/ consultants. Such mechanisms allow the university staff to acquire first hand information about the industrial problems. It was interesting to know about the existence of a Committee in the Department of Textile Technology at IIT Delhi i.e. Industry Interaction Committee, the memberships of which included twelve industry scientists besides the faculty members. This Committee was bridging the gap between textile industries and the department of textile technology at IIT.

Adjunct professorship can provide a solid base for continuing knowledge transfer from institution to industries. In this case, where a professional is an adjunct professor at an institute the company pays his salary for the period of

his stay at the institute. But in our survey of seven campuses, we could not find any Adjunct Professorship in any university/institute.

4.3.3 Consultancy

Consultancy as a profession of occupation is still in its infancy in Indian universities, although reputed technical organisations like IITs have a few well established consultancy services. These institutes can play a very important and useful role in the field of industrial consultancy as they have the largest concentrations of the most qualified personnel in various areas of science and technology. If a problem which an industrial concern wanted to investigate was entrusted to such an institute, it should be possible to deal with it satisfactorily by pooling the expertise available in academic departments. As the institutes gain more experience in this type of work, they can create suitable institutional mechanisms for handling consultancy works which should in due course improve the quality of both teaching and research.

The result of our field study of seven universities/institutes showed that in IIT Delhi, most departments had consultancy activities as a regular feature. Among the universities, while M S University and University of Delhi had consultancy activities, others did not have any such programme. The popularity of consultancy was found to be

associated with certain academic fields. It was frequently stated by most of the interviewed staff that consultancy in engineering faculty was at a much higher level than in either management or science departments. In the technical units of the universities, consultancy activities were most prevalent in the engineering departments due to the applied nature of their teaching and research programmes. At IIT Delhi, the general feeling was that one's excellence as an engineer was somewhat substantiated by his demand as a consultant by industries. It was also viewed that if a professor did not have extensive consultancy activities his professional competence was suspected because he was not then supposed to be conversant with of real problems of the industrial world.

IIT Delhi has established centralized listing of all the research interests and activities by its faculty members. It is thus possible for the industrial firms to come to the Institute with a particular problem and find out if the Institute had people with the required capabilities and expertise. This referencing system is used for contract work as well.

4.3.4 Industry's Participation in the Teaching Process:

This form of collaboration is usually initiated from the very beginning, namely, the determination of the objectives of the different programmes or courses of study, preparation of curriculum and course materials etc. Industry

should offer the services of some of its senior personnel either on a full time basis for a period of one or two years, or on a part time basis, so as to ensure a certain percentage of the teaching staff could be taken from the practical world of industry. In advanced countries, particularly in the United States and Canada, this is a common feature. The arrangement is mutually beneficial as the deputed person while returning to the parent institution also carries along with him new knowledge and fresh outlook.

During our field survey, we found that except in the cases of Jamia Millia and Bhopal universities, all other universities invited industrial personnel for teaching activities, particularly in the engineering and management disciplines. This type of arrangement was not seen in the JamiaMillia Islamia and Bhopal University, perhaps because these two universities had no engineering and management disciplines.

4.3.5 Seminar and Short Term Courses:

One of the methods of university-industry collaboration is organisation of seminars on topics of mutual interests. Academic personnel in all the universities surveyed by us stated that they attended seminars/workshops organised by industries. However, there were only four campuses where seminars were sponsored by industries i.e. IIT Delhi, M S University, University of Delhi and University of Rajasthan.

Another area where fruitful university industry cooperation could be expected was arrangement of short-term courses by universities in the newer branches of technology for the benefit of engineers who are serving in industries.

Out of the seven campuses we surveyed, only four were found to have been offering short-term courses of industrial relevance. The Ravi Shankar University offered such courses in the area of Industrial Psychology, while Delhi University maintained a University-Industry Interaction cell which Inter-alia was responsible for imparting short term courses of industrial relevance. The M S University, Baroda, was found to have been offering short-term courses of industrial relevance in such areas as Engineering and Management, while such courses were found to be available in all the departments of IIT, Delhi.

4.4. Technology Transfer

Programmes structured with a view to capitalising on University research or integrating technological results of research into private sector programmes or commercial products can be characterized as technology transfer mechanism.

Such programmes are designed to:

- i) Address specific research problems of a company;
- ii) give technical assistance to companies in need of developing new product lines; and

- iii) provide technical assistance in the development of a totally new business, or help entrepreneurs initiate their own high technology companies.

4.4.1 Extension Services:

Extension services are essentially used as means for bringing technical assistance to small companies or helping industry develop in rural areas. They constitute a service rather than a mechanism to facilitate cooperative teaching/research. However, these do help in the establishment of a network of contacts and make the universities more sensitive to the industrial needs.

During the field survey, we found prevalence of extension services in IIT Delhi and M.S University, Baroda. This type of cooperation exist particularly in engineering departments of both the universities.

4.4.2 Innovation Centre

Innovation centres are means of helping entrepreneurs for developing skills through prototypes to the point where they can start their own businesses. The major goal of these centres is the initiation of academic programmes to facilitate the work of young inventors and entrepreneurs.

Our survey of seven university campuses indicated that there were no innovation centres in these institutions. But

in the faculties of Engineering and Management of four universities (i.e. IIT Delhi, M S University of Baroda, Delhi University and Rajasthan University) there were programmes for students who wanted to develop entrepreneurial ideas and skills.

4.5 Initiation of University-Industry Interaction:

During our survey visit to the seven selected universities, we also tried to collect opinions of the university personnel on the existing programmes of university-industry interactions. Table-4 presents a total of 426 on-going interaction programmes out of which 60 per cent were initiated by the universities. Out of a total of 254 university-initiated programmes, 174 were in the knowledge transfer areas, followed by the areas of cooperative and general research support i.e. 45 and 30 respectively.

Industries initiated 17 per cent of total collaboration programmes covered by our study. Out of these 50 programmes were in knowledge transfer category, followed by the categories of cooperative research support (14), general research support (8) and technology transfer (1). About 11 percent of total interaction programmes were initiated mutually by universities and industries while the remaining 12 percent interaction programmes occurred because of universities having prior relationships with industries & vice-versa. The details of university-wise interaction programmes and the information about their initiator have

Table 4
Initiation of University-Industry-Interaction

	Types of Interaction	Initiator				Total
		University	Industry	Mutually	Prior Relationship	
1.	General Research Support	30 (1.0)	8 (1.9)	5 (1.2)	4 (0.9)	47 (11.0)
2.	Cooperative Res. Support	45 (10.6)	14 (3.3)	12 (2.8)	14 (3.3)	65 (20.0)
3.	Knowledge Transfer	174 (40.8)	50 (11.7)	28 (6.8)	32 (7.5)	284 (66.7)
4.	Technology Transfer	5 (1.2)	1 (0.2)	2 (0.5)	2 (0.5)	10 (2.3)
Total		254 (59.62)	73 (17.14)	47 (11.03)	52 (12.21)	426 (100.00)

Figures in parenthesis are the percentage to total.

been presented in table 5.

In our discussions with university staff we were given the impression that university-industry research interactions were considered desirable by both the parties. There was also consensus that there were no insurmountable barriers to joint university-industry research interactions. Some of the obstacles indicated by the university staff are: pre-publication review requirements and information dissemination restrictions of research findings, shortage of staff in academic departments and scarcity of laboratory equipments. Out of these, the last two were considered to be the most pressing by the university personnel. Table-6 present the detailed analysis of responses from the senior academic staff of various institutions, who have given their opinions about the factors that are responsible for low level of partnership between the institution and industries.

Table - 5

Institute of University/Industry Research Interactions
No. of cases of Each Category
(As derived from Interview Dates)

Research Interactions	Initiator									
	General Research Support					Cooperative Research Support				
Institution	Univ-ersity	Industry	Mutually Initia-tor	Prior Rela-tion-ship	Total No. of Initia-tor	Univ-ersity	Industry	Mutually Initia-tor	Prior Rela-tion-	Total No. of Initia-tor
1	2	3	4	5	6	7	8	9	10	11
IIT Delhi	26	8	4	2	40	20	8	4	3	35
Jamia Millia	1	-	-	-	1	1	-	1	2	4
Delhi University	1	-	-	1	2	10	1	3	4	18
Univ. of Rajasthan	-	-	-	-	-	2	-	1	1	4
M S University	2	-	1	1	4	10	5	2	3	20
Ravi Shankar Univ.	-	-	-	-	-	1	-	-	1	2
Bhopal University	-	-	-	-	-	1	-	1	-	2
Total	30	8	5	4	47	45	14	12	14	85

Research Interactions	Initiator											G. Total
	Knowledge Transfer Mechanism					Technology Transfer Mechanism						
	Univ- ersity	Industry	Mutually Initia- tor	Prior Rela- tion- ship	Total No. of Initia- tor	Univ- ersity	Industry	Mutually Initia- tor	Prior Rela- tion- Initiator	Total No. of Initiator		
Institution	12	13	14	15	16	17	18	19	20	21	22 = 6+11+ 16+21	

IT Delhi	65	30	5	5	106	3	1	1	-	5	185
Amia Millia	9	1	3	2	15	-	-	-	-	-	20
Delhi University	28	4	9	6	47	1	-	-	1	2	69
Univ. of Rajasthan	12	2	4	3	21	-	-	-	-	-	25
U S University	40	10	5	10	65	1	-	1	1	3	92
Ravi Shankar Univ.	5	1	2	1	9	-	-	-	-	-	11
Shopal University	15	2	-	5	22	-	-	-	-	-	24
Total	174	50	28	31	284	5	1	2	2	10	426

Note: ** Prior Relationship include: Professor having previously worked in Industry; Personnel or Industrial contacts etc.

Table - 6

**Barriers & Constraints to University-Industry Interaction
prevailing in Seven Campuses.**

University/ Institution	Types of Barriers							Total no. of Respondents
	Pre. Pub. review require- ments	Information dessemi- nation Restriction	Shortage of staff	Scarcity of lab. equip- ments	Others*	Mixed responses		
1. IIT Delhi	5 (14.7)	7 (20.6)	3 (8.8)	6 (17.6)	9 (26.5)	4 (11.8)	34 (100.0)	
2. University of Delhi	2 (6.3)	5 (15.6)	7 (21.8)	6 (18.8)	7 (21.9)	5 (15.6)	32 (100.0)	
3. M. S. University	1 (4.0)	2 (8.0)	7 (28.0)	8 (32.0)	2 (8.0)	5 (20.0)	25 (100.0)	
4. Univ. of Rajasthan	-	-	4 (20.0)	6 (30.0)	2 (10.0)	8 (40.0)	20 (100.0)	
5. R. S. University	-	-	7 (58.3)	3 (25.0)	-	2 (16.7)	12 (100.0)	
6. Bhopal University	-	-	6 (50.0)	4 (33.3)	-	2 (16.7)	12 (100.0)	
7. Jamia Millia	-	-	7 (46.7)	4 (26.7)	-	4 (26.7)	15 (100.0)	
Total	8 (5.4)	14 (9.3)	41 (27.3)	37 (24.7)	20 (13.3)	30 (20.0)	150 (100.0)	

Note: 1) *In this category we included in the barriers like, difference in the aim & value of universities and of industries, lack of flexibility in university structure

CHAPTER 5

PROMOTION OF LONG-TERM LINKAGES BETWEEN UNIVERSITIES AND INDUSTRIES

This chapter summarises several recurring themes and debates regarding university-industry interactions. An attempt is also made to raise some of the major issues pertaining to the promotion of long term linkages between universities and industries. The entire gamut of issues pertaining to such partnership are discussed under the following major categories.

5.1 The Significance of Current University-Industry Interactions

Inspite of the significance of university-industry interaction in promoting the processes of teaching, research and the consequent improvements in productivity and income, the direct financial support provided by the industry have been negligible. Out of the seven institutions surveyed by us only two were found to have received funds from industry to the extent of 18 percent and 3 percent of their total research funds (Table 3). The contributions of industries in relation to the total income is very meagre even in respect of technological institutes like IIT Delhi.

The dialogue between academia and industry has however increased and there seems to have been greater appreciation of mutual interests and problems as well as the respective goals especially those relating to the professional excellence and the well-being of people. This has apparently led to an increase in frequency of professional contacts between the two sectors. Because of the importance of prior contacts in the initiation of cooperative research programmes, the building up of a network of relations between universities-industries would facilitate the task of accelerating the pace of economic and social development.

While the partnership between industries and institutions are increasing rapidly, this phenomenon is limited to a few industries and institutions. Furthermore, although there is a wide spectrum of companies interacting with universities, there are very few which do so on a significant scale and on a continuing basis. Currently as is true historically as well, the most active industrial group, in all forms of university research support, and particularly in cooperative research interaction has been the electrical industry. The reasons as to why other types of industries are least interested or active in such partnership is difficult to discern at this stage.

While it is not clear whether external stimulus is necessary for promoting university-industry interaction, some degrees of government support seem desirable and it is

indeed. critical in many instances. The partners themselves have however been the key elements in successful development of programmes of mutual benefits. The Government, as a facilitator, can ensure that there is an appropriate climate for networking across the sectors, and may create conditions for increasing contacts and cooperation between the two sectors.

The Government support for basic research cannot be fully compensated for by industry nor the total financial requirements for carrying out R&D activities could be met by the latter. It is therefore important that government should strengthen the system of funding research so that university and industry could mutually agree to cooperate in the developmental potential of basic concepts particularly in the frontier areas of knowledge and technology for the following reason. The academic and theoretical researches in the fields of science and engineering subjects do not directly constitute the productive forces. These are in fact a pursuit for understanding and as such call for exploration of a variety of alternatives. The productive forces relate to the mechanisms of screening these alternatives after their characteristics have been better revealed. Industry, in some sense, cannot be expected to fund broad based exploration, but it would be of great value to industry to be able to tap into this exploration which have a direct bearing on productivity and the profitability. In view of this, industry can and should be able to fund the screening and testing of

alternatives. It follows that the interests of each party must be clearly identified so that a proper understanding could be developed with a view to ensuring a successful outcomes of partnership between industries and institutions.

5.2 Commercialisation of University Research

There is an increasing awareness on the part of universities-faculty and administration-to the opportunity for obtaining income from the commercialisation of university research. Universities have evolved a moderate source of income over the years from licensing of patents based upon their own research.

The concern for raising university finances creates a steady pressure on universities to move towards activities providing new sources of income through commercialisation of university teaching and research. As the level of Government funding has reached almost to the saturation point, the universities are in pressing need to mobilise resources from alternative sources especially industries. Such concerns provide essential stimulus for attracting and retaining competent staff in financially lucrative fields such as biotechnology, computer sciences etc.

The debate within the university centres largely focus on as to how the university can obtain additional income from participation in commercial ventures while maintaining its integrity and basic values associated with the concepts of

education and development. A number of serious questions arise concerning research priorities, criteria for selection of faculty, selection of graduate students based upon criteria related to ultimate commercial interests, effects of secrecy in research on community interaction and information dissemination, and possibly the damaging effects on university-industry relations of university equity participation in new commercial ventures.

5.3 Instrumentation and Research Facilities

The condition of the physical infrastructure of university research is both a cause and effect of rising research costs. Modern research depends upon advanced instrumentation which invariably raises the capital costs per researcher. And when adequate funds are not available the quality of research suffers. The strengthening of the physical infrastructure is a critical issue to day, and will remain so. It affects both the training and research objectives which are sought by industry in its relationship with universities. The adequacy of university research facilities can alone stimulate and strengthen the cooperation between the two sectors. This, therefore, requires identification of (i) means of financing research facilities including instrumentation (ii) the select institutes which should be encouraged for developing research capabilities; and (iii) the mechanism of sharing the common facilities.

Thus, without the development of research resources, the promotion of partnership will remain an elusive objective.

5.4 Changing Requirements for Technical Personnel

There are instances of extreme shortages of experts in particular areas, and one may anticipate continuing and emerging shortages in others. Simultaneously, there is a low demand and/ or underemployment in some technical disciplines. This situation raises several issues related to the nature and extent of university-industry cooperation.

The primary objective of industry in its interactions with university system is to ensure the production of new graduates with adequate knowledge, skill and training which are needed for boosting the industrial activities. There have however, been ups and downs in the individual fields of science and technology, relative to other fields, appearing almost as short-term perturbations within the general cycle of supply of and demand for various types and levels of educated manpower. Industrial demand for technical personnel appears to be affecting the traditional university structure in two ways:

- i) Fewer doctoral candidates: Graduates in computer sciences with bachelor's or master's degrees are going directly to industrial carriers, with a smaller proportion than expected going on to for a doctorate

degree. This diminishes the pool of those pursuing advanced research and for those available as future faculty; and

- ii) Drain of advanced university personnel: In computer sciences and genetics (as well as some engineering disciplines), both faculty and new doctoral graduates are turning to industrial positions. This drain to industry raises critical questions about the resources available for training the needed future graduates and maintaining the desired research base at universities.

The problem of mismatch between the supply of and demand for specialised manpower could be tackled by mutual sharing of resources, in which case the industry would have the benefit of specialized services of university staff while the latter would attract funds for financing teaching and research programmes.

5.5 Collective Industrial Activities

The promotion of collective industrial activity is another method of rectifying the deficiency in infrastructural facilities for research among the educational institutions. The collective efforts initiated by industry is generally in the form of industry-oriented institute which is supported by several companies.

There are several issues related to such collective industry actions. First, a major purpose is to use collective action to supplement, not to replace, support of university research by the individual companies. How best to do this, and how to maintain ties between the individual companies and the appropriate university personnel are subjects for continuing attention and discussion.

The second issue is as to what role the Government might play as different industries collectively increase their own support of the science and engineering relevant to their needs. If the trend continues for collective industry action to identify and support relevant needs in a mission oriented field, much of the justification for support of research by the Government might then intensify in the area of general infrastructure for pursuing teaching and research in the area of basic science and technology.

The third issue is related to the fact that collective industry actions will inevitably strengthen particular areas of the branches of science and engineering, and most probably, particular departments and universities. Industry is free to concentrate its spending on the most appropriate institutions in its fields of interest without any external influences. If sufficiently concentrated, such funding will have the desirable impact on the development of select universities.

The overriding issue, however, is as to how to ensure that the industry support of university research maintain balance and provide new inputs for widening the technical base. The extent and the magnitude of industry support in the foreseeable future should be such that increased university-industry cooperation could bring about desirable technical change in every sphere of development. The Government through its own mechanism should make positive interventions for sustaining an appropriate balance in respects of funding educational programmes across the institutions and disciplines.

5.6 Non-University Training

There appears to be an increasing involvement of non-university organisations in initiating or expanding programmes intended to provide some form of organised advanced education and training that do not involve the participation of a university.

A wide range of courses having direct relevance to industry and business are organised by the professional societies with a view to providing advance technical training. The nature of courses and training may be categorised as under:

- i) A particular subject that would add specific knowledge in a new field for current employees;

- ii) A formal set of courses that would permit existing technical employees to keep abreast with the new advances in their fields of specialization or provide the basis for a switch over to a new field;
- iii) A formal set of courses for new employees that would acquaint them with the theoretical and experimental state of the art in industry, assuming of course, that such courses were more advanced than their previous university training as perhaps in computer sciences; and
- iv) A formal degree-granting programme run by a company or industry for either current employees who wish to advance themselves, or potential new employees required by the company or industry.

The first two categories have been common over the years. They address questions about obsolescence of individuals or the decline in relevance of technical fields. While these problems are often solved with the cooperation of local universities, they may indeed be organised by a company or industrial organisation in order to tailor the material to the knowledge available within that company or organisation.

The second two categories, however, may take on more significance in terms of the ability of universities to

deliver services in rapidly advancing high technology industry fields. To some extent they address the questions of personnel shortages in these fields, of loss of faculty that could teach these subjects in a university, and of the university lagging behind industry in the use of the most advanced research facilities in imparting knowledge. If the problems engendering the apparent growth in industrial training programmes are short-term, the issue and mechanisms will disappear or at least level off to find a modest place in our technical structure. If the problems remain, or even if the mechanisms remains at a high level as a continuing feature of technical training, then a new set of questions arise for the university, and for the university/industry cooperation.

There are clearly opportunities for training outside the university system that can complement the university's role. Occasionally, industry is at the vanguard in developing exploratory or innovative teaching programmes that can point the way to new initiative for the university. The growth of such external programmes should at least stimulate both analysis and introspection by universities in examining their optimum role in society in general, and with regard to industry in particular. It must be noted that the failure of universities to provide education and training in emerging areas of science and technology would considerably lessen their importance in the context of development, the

implication of which would be the steady deterioration of university system and its contributions to economic and social progress.

5.7 Internal Structure of University

The primary and unique function of a university is to provide students with a broad range of disciplines and curricula resulting in the awards of degrees/diplomas. A principal additional function, particularly within university faculties, is the pursuit of research. The inter-dependence of the two objectives of education and research is considered to be critical.

Although industry intracts with universities for the same objectives and with almost the same order of priorities, its own structure and organisational approach to research is different than that of a university. One can reasonably expect that some organisational structure within a university is optimum for the objective of encouraging and improving the effectiveness of such interactions. This does not mean however that the structure of traditional internal operations of a university is reasonably satisfactory. The issue raised as a factor in future university/industry cooperation is as to how to modify the university structure to maintain the strength and integrity of its basic functions while attempting to meet changing external conditions and internal pressures.

There are many structural aspects of a university, the most important among them are:

- i) Grouping of scholars by disciplines, with academic administrators responsible for traditional discrete institutions;
- ii) Appointment bestowed by departments; and
- iii) Tennure granted by faculty within a department generally tied to teaching obligations.

The elements have evolved with the growth of the modern university. They are at the heart of the freedom and objectivity of scholarly research. They encourage and strengthen individual research. Unfortunately, they also form disincentives to inter-university research, which focusses on a mission or objective that may call for coordination of contributions by many disciplines. Yet that is precisely the essence of industrial research. Industry relates its technical needs to business planning in terms of products and processes, and sets technical priorities in terms of properties and specifications.

The issue before the university is to be aware of the interdisciplinary approach inherent in industrial research and explore its own flexibility to meet such requirements. Such exploration is evident in the creation of research centres and institutes to form a type of matrix structure at

some universities. Where these institutes are within a well defined department, they tend to lack the broadest attributes of a mission - oriented structure. Where these are free of this constraints, there tend to be strains between those personnel on research appointments at the institutes and the traditional department appointments. These are, some problems to be resolved.

The latter is, however, related to the question of tenure appointments and criteria. While there has been steady growth in university personnel engaged in R & D, it does not normally open up new career opportunities unless tied to teaching programmes. This is a critical structural question for the universities, particularly in areas of shortages of teaching staff. If industry were to make substantial funds available for research in particular areas, but the universities could not make tenure track appointments, there would probably be little change in the research capabilities of the universities.

5.8 Gaps in Communication

A number of professors interviewed by us mentioned that they received little or no industrial support. While they were not specifically negative towards industrial support, they held the view that industry had no interest in what they were doing, or that what they were doing was of no immediate value to industry. Therefore, they had not considered seeking

industrial support. Furthermore, they were not aware as to how to approach the industry. To some extent, the perception of the lack of immediate relevance of their research to industry was found to be correct. Many science-based companies were found to be quite comprehensive in their attempts to keep themselves apprised of research relating to their interests. Through technology scanning activities, the industry executives generally discovered those in the university community doing research of interests to them. This calls for improving the communication channel between universities and industries in respects of the services they can render to each other.

A P P E N D I X - 1

University - Industry Interactions

(Interview Schedule for University Personnel)

1. In what type of university-industry interaction your institution/department is involved?
2. What are the basic reasons for having such interactions?
3. What is your opinion, should be the ideal form of university-industry interactions?
4. What have been the policies and practices of your institution/department for promoting university-industry interactions?
5. Would you like to see increase in university-industry interactions?
6. Describe the most outstanding university-industry interaction that your institution/department has experienced over the past two years:
 - (i) Name of industry
 - (ii) Brief outline of the programme
 - (iii) Duration of the programme
 - (iv) Which party initiated the programme-industry or university?
 - (v) Who specifically was responsible for initiation the programme?

(Please indicate the person's status in the University/Industry)
 - (vi) To what extent did previous interaction, if any, facilitated the initiation of this programme?
 - (vii) What were the specific objectives/goals when the programme was initiated?
 - (viii) What were the specific arrangements for staffing and administration?

7. What were the initial problems/barriers to the establishment of this programme?
8. What were the resource commitments arranged between the partners?
9. What were the basic causes generating your interests and active cooperation in the programme?
10. Were there any legal issues to be sorted out before initiating the programme, especially those relating, to ownership right for research funding or patent protection? If so, please indicate in brief.
11. What is your overall comment upon the programme?

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